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Telemedicine-delivered treatment interventions for substance use disorders: A systematic review

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ABSTRACT

With increased negative impacts from opioid and other substance use disorders in the US, it is important for treatments to not only be effective, but also accessible to patients. Treatment delivery via telemedicine, specifically, the use of videoconferencing, which allows real time communication between a patient and a clinician at a distant site, has been shown to be an effective approach for increasing reach and access to treatments for mental health disorders and other chronic illnesses. This systematic review identified and summarized studies examining the effectiveness of telemedicine interventions to deliver treatment for patients with substance use disorders. Out of 841 manuscripts that met our search criteria, 13 studies met the inclusion criteria. Studies covered interventions for nicotine, alcohol and opioid use disorders. They varied widely in size, quality, and in the comparison groups examined. Studies examined both delivery of psychotherapy and medication treatments. Most studies suggested telemedicine interventions were associated with high patient satisfaction and are an effective alternative, especially when access to treatment is otherwise limited. However, there were substantial methodological limitations to the research conducted to date. Further studies are needed, including larger scale randomized studies that examine different models of telemedicine that can be integrated into existing healthcare delivery settings, to increase the use of effective treatments for patients with substance use disorders.

1. Introduction

Over the last several decades, the US has seen a dramatic increase in the prevalence of a number of substance use disorders (SUDs) and associated harms. The epidemic of opioid use disorders persists with over 42,000 people dying of opioid overdose in 2016 (Hedegaard, Warner, & Minino, 2017). In addition, there have been increases in overdoses involving cocaine use and an almost 50% increase in alcohol use disorders over a recent ten year period (Grant et al., 2017; Seth, Scholl, Rudd, & Bacon, 2018). Despite the impacts of SUDs, utilization of effective treatments remains low (Park-Lee, Lipari, Hedden, Kroutil, & Porter, 2017). A major factor contributing to low utilization rates is access, especially to evidence-based medication and psychotherapy treatments for SUDs (Cummings, Wen, Ko, & Druss, 2014). In addition, there are major disparities in treatment access, with particularly low access to effective treatments in rural areas (Andrilla, Moore, Patterson, & Larson, 2018), where there is often difficulty recruiting and retaining qualified providers (McGrail, Wingrove, Petterson, & Bazemore, 2017). Thus, there is a pressing need to develop and implement new systems of treatment delivery that can increase reach and access to effective treatments.

Telemedicine covers several modalities including asynchronous and synchronous technologies and is an important tool that can potentially increase access to effective SUD treatment. Asynchronous or store and

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forward technologies allow for electronic transmission of medical information, such as digital images, while synchronous or live videoconferencing technologies connect providers and patients in real time for direct care delivery (Center for Connected Health Policy, 2018). Key healthcare payers in the US, including Medicare and Medicaid, often reimburse synchronous telemedicine only if it contains both audio and video components (i.e. videoconferencing) (Center for Connected Health Policy, 2018). Therefore, in this review, we specifically focused on interventions that directly deliver treatments, including either medication or psychotherapy for SUDs, by providers in one location to patients in another through use of synchronous videoconferencing. Medication treatment in these studies typically involved connecting a physician or other medication provider via videoconference who can prescribe a specific medication treatment for SUDs. Psychotherapy involved connecting a therapist to deliver psychotherapy. Use of other modalities such as remote monitoring (using technology to collect patient health information), telephone, text or web-based interventions (often considered mHealth) or use of telementoring (training and consultation by specialists) were not directly addressed. Prior reviews have examined use of these other technology-based interventions for SUDs (Gainsbury & Blaszczynski, 2011; Tait, Spijkerman, & Riper, 2013; Tofighi, Abrantes, & Stein, 2018; Tofighi, Nicholson, McNeely, Muench, & Lee, 2017; Young, 2012).

There have been numerous studies and reviews examining the effectiveness of real-time videoconferencing delivered psychotherapy and medication treatment for mental health disorders including depression and PTSD (Hilty et al., 2013; Turgoose, Ashwick, & Murphy, 2017). These studies have generally shown telemedicine delivered treatments are no less effective compared to in-person treatment and are associated with high patient satisfaction. In recent years, telepsychiatry has burgeoned with numerous models developed including collaborative care and other models in primary care and other clinical settings (Fortney et al., 2015; Hilty et al., 2018). In contrast, there has been limited literature synthesizing findings on telemedicine-delivered SUD treatment. The telemedicine literature on mental health disorders should substantially inform effectiveness of interventions for SUDs, but studies specific to the SUD patient and provider populations are still needed given potential differences in the treatment modalities and patient and provider populations. SUDs are complex disorders of impaired behavioral control where patients may minimize symptoms including substance use. The core of the treatment relies on provider-patient rapport to elicit subjective reports of substance use with monitoring through urine toxicology. This could potentially affect treatment especially when prescribing a controlled medication, such as buprenorphine or methadone for the treatment of opioid use disorder. Thus, telemedicine treatment models for SUDs need to be assessed for effectiveness and acceptability to both patients and providers, which may affect future uptake.

There has already been substantial interest from lawmakers to increase telemedicine-delivered treatment for SUDs. The recently passed SUPPORT for Patients and Communities Act (Walden, 2018) contains several provisions to support further use of telemedicine for SUDs. In addition, a handful of states are considering or have passed legislation related to SUD treatment via telemedicine including Maryland HB 0983, Illinois SB 3049, and California AB 2861. However, there are also additional federal and state regulations that place restrictions on telemedicine delivered SUD treatment, including the Ryan Haight Online Pharmacy Consumer Protection Act of 2008, which governs telemedicine prescribing of controlled medications, such as buprenorphine treatment for opioid use disorder (Center for Connected Health Policy, 2018; United States Code (USC), 2016). Given the broad interest in further use of telemedicine for delivering treatment to patients with SUDs, it is critical to understand the effectiveness of these interventions.

California's legislation, Assembly Bill 2861, was signed into law in September 2018, and will allow the state's Medicaid program to reimburse for telemedicine services provided for SUD treatment. The California state legislature had requested that the California Health Benefits Review Program (CHBRP) conduct a systematic review for use in deliberation of this legislation (California Health Benefits Review Program, 2018). CHBRP is a task force comprised of University of California faculty and researchers who provide an independent, unbiased assessment of the impacts of proposed legislation related to health insurance benefits. The current team conducted the systematic review. We describe the evidence on telemedicine delivered medication and psychotherapy treatments for patients with SUDs. In addition, we identify major gaps in the literature to inform future research on new models of telemedicine to deliver effective treatments across SUDs.

2. Methods

2.1. Search strategy and selection criteria

The literature review was conducted by a medical librarian at the University of California, Davis in March 2018 and updated October 2018. Articles addressing videoconferencing for SUD were identified through database searches using Cochrane Library, Embase, PsycINFO, PubMed, Scopus, and Web of Science. Additional searches were conducted using websites that index or produce systematic reviews and meta-analyses such as: National Institute on Drug Abuse (NIDA), the Substance Abuse and Mental Health Services Administration (SAMHSA), the Agency for Healthcare Research and Quality (AHRQ), the National Health Service (NHS) Centre for Reviews and Dissemination, the National Institute for Health and Clinical Excellence (NICE), and the International Network of Agencies for Health Technology Assessment (INAHTA).

The search was limited to abstracts of studies published in English from January 1998 through October 2018. In June 2018, the authors searched the gray literature to identify eligible articles not in electronic databases, including research not yet published. We searched websites of conferences related to substance use disorders and searched Google Scholar. References from included articles meeting search criteria and from review or summary articles on telemedicine interventions for substance use disorders (Molfenter, Boyle, Holloway, & Zwick, 2015; Young, 2012) were reviewed for additional sources that met review criteria.

The search was conducted using the pairing of telemedicine keywords: (telemedicine, telehealth, telepsychiatry, telepsychology, telemental health, live video, and videoconferencing) with substance use related terms (substance use disorders, substance abuse, addiction, alcohol, alcoholism, tobacco, cannabis, marijuana, stimulant, hallucinogen, and opioid). The full set of search terms and conferences searched are included in Appendix A.

2.2. Inclusion and exclusion criteria

Studies that were included were required to examine real-time videoconference-delivered medication or psychotherapy intervention to treat adults with SUDs. Given the limited research that has been published, we used broad inclusion criteria to include studies that were randomized, experimental, quasi-experimental or observational in design. Single case reports or commentaries that lacked patient level data were excluded. Studies must have included either a comparison group or measurements at multiple time points (i.e. at least baseline and a follow-up time point). We included studies that addressed any SUD, including nicotine use disorder. The outcomes of interest included substance use, treatment adherence, acceptability of the intervention, and satisfaction with treatment.

2.3. Data extraction

The search yielded 841 studies after removing duplicates. Titles and abstracts of these studies were reviewed to determine eligibility for

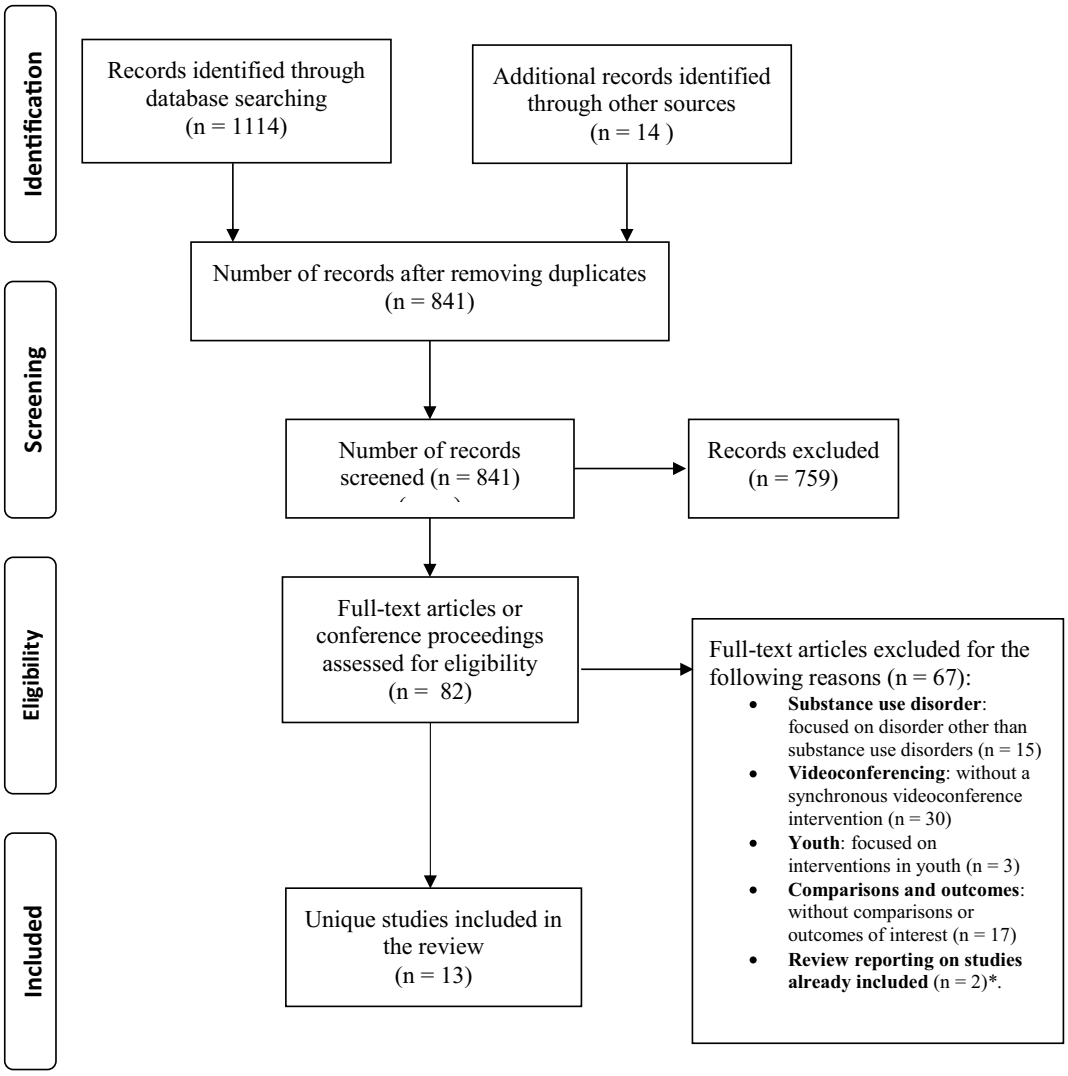

Fig. 1. Study flow diagram.
*An additional 2 articles that presented on the same study as included studies were included in analyses (Tarp, Bojesen, et al., 2017 and Tarp, Mejldal, & Nielsen, 2017 described the same study; Chang et al., 2018 and Weintraub et al., 2018; described the same study).

inclusion. Of these, 82 were deemed to meet potential eligibility criteria and full-text articles were assessed for eligibility by two reviewers (DC and SM). 13 published manuscripts of 12 unique studies met eligibility for inclusion in this review. Studies published from the same trial were examined together to avoid redundancy (Tarp, Bojesen, Mejldal, & Nielsen, 2017; Tarp, Mejldal, & Nielsen, 2017). Two conference proceedings also met inclusion criteria, though one was a conference abstract of one of the published studies (Chang, Welsh, Weintraub, & Currens, 2018; Weintraub, Greenblatt, Chang, Himelhoch, & Welsh, 2018). In total, these 13 studies included seven randomized controlled trials (including several pilot studies), one quasi-experimental study, two non-randomized pilot studies, and three retrospective studies (Fig. 1).

The PRISMA standards were used to guide reporting of this systematic review (Moher, Liberati, Tetzlaff, Altman, & Group, 2009). Potential risk for bias was assessed for all included studies using guidance from the Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green, 2011). Assessment of risk of bias was categorized into six domains for randomized controlled trials (RCTs) including: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, and selective reporting. Random sequence generation and allocation concealment are ways to minimize selection bias through steps to ensure participants are randomly assigned and there is no prior knowledge of an individual's assignment. Blinding of participants and personnel reduces the chance that knowledge of which intervention is received rather than the intervention itself affects outcomes and blinding of assessments reduces the risk that this knowledge affects outcome assessment. Minimizing incomplete outcome data involves, for example, taking steps to quantify and understand reasons for missing data. Minimizing selective reporting involves including descriptions of all outcomes measured to minimize chance of only reporting significant results. Reviewers assessed each study for risk of bias along these domains using specific guidance from the Cochrane Handbook recommendations. Judgments about level of bias were categorized as “low risk,” “high risk,” and “unclear risk.” Assessment of risk of bias for non-randomized studies used a different set of questions because there is wider variation in potential risk for bias given the numerous types of methods used in non-randomized studies. Guided by the Cochrane Handbook, we categorized sources of bias in non-randomized studies by examining study design features using the following six questions: 1) was there a comparison? 2) how were individuals/groups assigned? 3) was allocation prospective? 4) was outcome assessment prospective? 5) was hypothesis generation prospective? 6)

Table 1
Summary of included study characteristics examining telemedicine interventions for SUDs.

Authors	Design	Location	Patient population	Sample	Outcome measures
Tobacco					
Carlson et al., 2012	Non-randomized comparison	Canada, Alberta	General population	*n* = 554; Mean Age = 47 years; 68% Female; No race/ethnicity data	Tobacco cessation defined as 3-month continuous abstinence (self-report); Acceptability/Satisfaction (program evaluation questions and videoconferencing evaluation questions)
Kim et al., 2016	RCT	U.S., nationwide	General population	*n* = 49; Mean Age = 45 years; 100% Female; 100% Korean ethnicity	Abstinence (Self-reported; salivary cotinine test to measure cotinine); Satisfaction (Client satisfaction questionnaire)
Richter et al., 2015	RCT	U.S., Kansas	Primary care patients	*n* = 566; Mean Age = 47.4 years; 64.8% Female; 82.9% Caucasian, 9% Hispanic	Abstinence (self-report and salivary cotinine and carbon monoxide); Attendance (therapist records) Satisfaction (satisfaction questions); Intervention fidelity (recordings coded for adherence); Pharmacotherapy use (self-report); Quit attempts (self-report); # cigarettes per day (self-report); Cost analysis
Alcohol					
Baca & Manuel, 2007	RCT	U.S., New Mexico	General population	*n* = 30; Mean Age = 36.6; 43.3% Female; 34.5% Caucasian, 34.5% Hispanic, 13.8% American Indian, 6.9% African-American, 3.4% Asian, and 6.9% other	Satisfaction with treatment and counselor utilizing a Likert scale and preferred mode of treatment (videoconference, telephone or face to face)
De Leo et al., 2014	Single arm pilot	U.S., South Carolina	Primary care patients in VA	*n* = 25; Veterans; No other demographic data	Reported average and peak alcohol consumption
Frueh et al., 2005	Single arm pilot	U.S., South Carolina	Patients in substance use disorder (SUD) clinic in VA	*n* = 18; Mean Age = 52 years; 100% Male; 83% African American 17% Caucasian	Abstinence (chart review); Satisfaction (treatment satisfaction, treatment credibility and telemedicine satisfaction questionnaires; qualitative interview); Treatment attendance (chart review)
Staton-Tindall et al., 2014	RCT	U.S., Kentucky	Clients from rural community supervision offices (i.e. justice-involved)	*n* = 127 Mean Age = 30.5 years; 81% Male; 98% White;	Alcohol use (self-report); Attendance (# of completed sessions)
Tarp, Bojesen, et al., 2017; Tarp, Mejldal, & Nielsen, 2017[a]	RCT	Denmark, Odense	Patients in outpatient alcohol use disorder clinic	*n* = 71; Mean Age = 47 years; 27% Female No race/ethnicity data	Alcohol use (self-report); Attendance (premature dropout at 6-month follow-up, number of days in treatment)[a]; Treatment satisfaction (satisfaction questionnaire and questions about technical equipment and semi-structured interviews)
Opioids					
Chang et al., 2018; Weintraub et al., 2018	Retrospective study	U.S., Maryland	Outpatients in opioid use disorder (OUD) treatment clinic	*n* = 177; Mean Age = 35.1 years; 10.7% Female; 14.5% African American, 84.3% Caucasian, 1.2% Hispanic	Treatment retention; opioid use by urine toxicology
Eibl et al., 2017	Retrospective Comparison	Canada, Ontario	Outpatients receiving opioid agonist treatment	*n* = 3733; Mean Age = 31 years; 59% Male; No race/ethnicity data	Abstinence (urine toxicology via medical record); Treatment retention (medical record)
King et al., 2009	RCT	U.S., Maryland	Outpatients in OUD treatment clinic	*n* = 37; Mean Age = 41 years; 62% Female; 44% “Minority”	Abstinence (Urine toxicology); Attendance; Satisfaction (Patient Satisfaction Survey)
King et al., 2014	RCT	U.S., Maryland	Outpatients in OUD treatment clinic	*n* = 59; Mean Age = 41; 56% Female; 36% self-identified “Minority”	Abstinence (Urine toxicology); Attendance; Satisfaction (Client Satisfaction Questionnaire); Therapeutic Alliance (Helping Alliance Questionnaire); Monetary Value (Multiple Choice Procedure Questionnaire)
Zheng et al., 2017	Retrospective comparison	U.S., West Virginia	Outpatients in OUD treatment clinic	*n* = 100; Mean Age = 36 years; 54.5% Female; 94% Caucasian	Abstinence (self-report and urine toxicology in medical records); Treatment retention (medical records)

[a] Substance use and treatment attendance outcomes reported in (Tarp, Bojesen, et al., 2017) and satisfaction reported in (Tarp, Mejldal, & Nielsen, 2017).

Table 2
Summary of included study results examining telemedicine interventions for SUDs.

Authors	Study arms sample sizes	Intervention type[b]	Intervention summary	Follow-up period	Statistical method	Effect size	Summary of results
Tobacco							
Carlson et al., 2012	Overall: $n = 554$; In-Person ($n = 370$); Telemedicine ($n = 184$)	Psychotherapy	Eight 90-min smoking cessation group therapy sessions over 15 weeks offered either in-person or via telehealth videoconference to remote sites that had teleconferencing equipment in place.	3, 6, and 12 months	Intent to treat analysis (ITT); Available data analysis	ITT: 3 months: in person quit rate 27.3% vs telehealth 25.5% ($p = .66$); 6 months: in-person 13.5% vs. telehealth 14.1% ($p = .84$); 12 months: in-person 21.1% vs telehealth 25.5% ($p = .24$) Satisfaction: 84% in telemedicine arm were satisfied with quality of services (no direct comparisons).	No significant differences in continuous abstinence rates between the in-person treatment group and telemedicine group. Program evaluations were positive for both groups.
Kim et al., 2016	Overall: $n = 49$; Telephone ($n = 25$); Telemedicine ($n = 24$)	Psychotherapy[c]	Eight 30-min weekly individualized counseling sessions of a culturally adapted smoking cessation intervention delivered via telephone or videoconference to participants' homes. Participants in both arms also received nicotine patches, educational materials, and family coaching.	1,2 and 3 months follow-up	Intent to treat analysis (ITT) using survival analysis	1 month follow-up: Self-report abstinence in phone 48.0% vs video 66.7%; 2 month follow-up: Self-report abstinence in phone 52.0% vs. video 58.3%; 3 month follow-up: Self-report abstinence in phone 40.0% vs. video 41.7%; Cox proportional hazard ratio 0.86, 95% CI 0.36–2.02)	Telemedicine feasible and acceptable for younger Korean women < 50 years of age. Participants reported comparable abstinence in both groups.
Richter et al., 2015	Overall: $n = 566$; Telemedicine ($n = 280$); Phone ($n = 286$)	Psychotherapy	4 counseling sessions for smoking cessation using a Combined Behavioral Intervention (CBI) approach via clinic-based video telemedicine to primary care office or phone to participant's home or cellphone. All participants received educational materials and guidance to help them select nicotine cessation medications.	3, 6, and 12 month follow-up	Intent to treat analysis (ITT)	Biochemically verified abstinence at 12 month follow-up telemedicine 9.8% vs phone 12.0% ($p = .406$). Satisfaction: 73.2% of all participants very satisfied with no significant difference between arms. Videoconferencing participants more likely to recommend to friends or family.	Telemedicine was no better than phone for abstinence. Telemedicine group with more medication use. Phone less costly. Both groups reported high satisfaction.
Alcohol							
Baca & Manuel, 2007	$n = 30$ participants randomized to telemedicine, telephone or in-person	Psychotherapy	2 motivational interviewing sessions; first immediately after intake and second, within 2 months of the first session. Location of intervention delivery not specified.	Following each intervention session. No further followup.	One way ANOVA across three groups on demographic and pre-intervention level of drinking. ANOVA across 3 groups comparing satisfaction and X^2 comparing preferred mode	No significant difference in preference across the 3 modes $F(2, 26) = 2.6$, $P > .05$. When participants were asked to choose between telephone or videoconference, videoconference was preferred (64.3%) over telephone (35.7%)	Preliminary findings suggesting participants found videoconference and telephone to be as acceptable as in-person counseling.
De Leo et al., 2014	N = 25 telemedicine	Psychotherapy	4 weekly 1-hour individual psychotherapy sessions to reduce alcohol use delivered to participants' homes via videoconference.	2 months	Paired *t*-tests comparing baseline and 2-month follow-up	Available data: $t = -2.63$, $p < .05$ comparing baseline and 2-month follow-up for reported standard ethanol content (SEC). $t = -3.74$, $p < .01$ for reported peak SEC.	Preliminary findings suggesting intervention associated with reductions in average and peak alcohol consumption.

(*continued on next page*)

Table 2 (*continued*)

Authors	Study arms sample sizes	Intervention type[b]	Intervention summary	Follow-up period	Statistical method	Effect size	Summary of results
Frueh et al., 2005	Telemedicine: $n = 18$	Psychotherapy	Eight one-hour group therapy sessions focused on relapse prevention strategies delivered via videoconferencing over four weeks delivered in a medical center.	Following the 4-week treatment period	Descriptive	No statistical tests. Satisfaction (of study completers): mean score on general measure of treatment satisfaction indicated high satisfaction. 82% would recommend to friend or family.	Participants completed on average 6.4 sessions. Participants reported high levels of satisfaction.
Staton-Tindall et al., 2014	Overall: $n = 127$; Telemedicine ($n = 61$); Usual care ($n = 66$)	Psychotherapy	Up to 5 sessions of motivational enhancement therapy to participants in community supervision office via videoconference plus usual care vs. usual care, which included assessment and referrals to community services.	3 months	Intent to treat analysis (ITT) controlling for baseline alcohol use; Per-protocol analysis	ITT: Any alcohol use telemedicine vs usual care OR: 1.29 (CI: 0.55–2.99)	No differences between groups on alcohol use outcomes in ITT analyses. Per protocol analyses found people who completed 3–5 sessions in telemedicine group had fewer days of drinking at follow-up.
Tarp, Bojesen, et al., 2017, Tarp, Mejldal, & Nielsen, 2017[a]	Overall: $n = 71$; In-person ($n = 39$); Telemedicine ($n = 32$)	Psychotherapy[d]	Usual care was outpatient treatment program for alcohol use disorders with multi-disciplinary staff delivering medications and psychotherapy. Psychotherapy was individualized and included CBT, supportive consultations, family therapy, etc. Average duration of treatment was 7 months. Sessions were 30–60 min 1 to 3 times a week at the start and every other week later on. Telemedicine group received usual care. In addition, they were offered optional videoconferencing delivered therapy via laptop to any location and could choose this each session.	3, 6, 9 and 12 months during treatment and at treatment termination for substance use, retention and satisfaction outcomes	Kaplan Meier survival analysis for retention and substance use outcomes. General inductive approach for qualitative interviews.	At 180 days in treatment, in-person 31% and video 6% had dropped out prematurely ($p = .008$) Satisfaction: average satisfaction scores ranged from 4.28 to 4.47 on 5 measures of treatment satisfaction (on Likert scale of 1–5) with no significant difference between groups	Lower dropout at 6 months from telemedicine group. No differences in treatment satisfaction.
Opioids							
Chang et al., 2018, Weintraub et al., 2018	$n = 177$ telemedicine	Medication	Telemedicine-delivered buprenorphine treatment to outpatient SUD clinic.	1, 4, 8 and 12 weeks	Just descriptive	N/A	Treatment retention at 12 weeks was 57.4%. 86.1% of urine toxicology were negative for presence of opioids at 12 weeks.
Eibl et al., 2017	Overall: $n = 3733$; Predominantly in-person ($n = 1570$); Predominantly telemedicine ($n = 1745$); Mixed ($n = 418$)	Medication	Methadone treatment for opioid use disorder delivered in-person or via telemedicine (patient presents at local clinic with nurse and are connected to a physician at a distant site via videoconference)	Followed to treatment discontinuation or max follow-up date of 6/17/2013	Cox Proportional Hazard Regression (adjusted for age, sex, region, rurality, peak methadone dose)	One-year retention in predominantly telemedicine 50% vs. predominantly in-person 39% (AOR: 1.27; $p \leq .001$)	Patients treated predominantly via telemedicine more likely to be retained on methadone treatment than those treated in-person.

(*continued on next page*)

Table 2 (*continued*)

Authors	Study arms sample sizes	Intervention type[b]	Intervention summary	Follow-up period	Statistical method	Effect size	Summary of results
King et al., 2009	Overall: n = 37; Telemedicine (n = 20); In-person (n = 17)	Psychotherapy	6 weeks of twice weekly 1-hour group therapy sessions via an internet-based videoconferencing platform (E-Getgoing) to participants' homes or on-site group sessions incorporating relapse control therapy for patients who were also in methadone treatment	Assessment during 6-week intervention	Just descriptive	Counseling adherence: In-person 76% vs video 92% (p = .07) Drug positive urine specimens: In-person 42% vs video 37% p = "*ns*" Satisfaction: scores on 5 measures of patient satisfaction ranged from 3 to 4 (scale of 1 = least satisfied to 4 = most satisfied) for both video and in-person groups.	No difference in treatment adherence or substance use in in-person vs telemedicine groups. Participants reported high satisfaction across both groups.
King et al., 2014	Overall: n = 59 In-person (n = 35) Telemedicine (n = 24); Overall 85 participants were randomized but 26 participants from the telemedicine arm failed to complete registration for the technology and withdrew from study	Psychotherapy	12 weeks of individual weekly counseling session of 30–40 min via an internet-based videoconferencing platform (E-Getgoing) to participants' homes or in-person for patients who were also receiving opioid agonist treatment	Assessments during intervention	t-tests; Chi-square tests; Mixed model analyses	Attendance: In-person 6.1 vs video 5.4 p = .367 Positive urine toxicology: In-person 9% vs video 11% (p = .831). Satisfaction: Mean scores on Client Satisfaction Questionnaire for video was 3.8 (SD 0.31) versus in-person 3.6 (SD 0.52) at study end point and not significantly different (p = .207) between groups at 12 week follow-up.	26 participants withdrew from the telemedicine arm before receiving treatment. Among the rest, no significant difference in session attendance, abstinence, satisfaction, therapeutic alliance.
Zheng et al., 2017	Overall: n = 100; Telemedicine (n = 46); In-person (n = 54)	Medication[e]	Buprenorphine treatment program for opioid use disorder through in-person or videoconference to patients in a rural clinic. Both medication treatment and therapy were delivered in group setting. All patients also required to attend at least 4 12-step meetings a week and provide random urine toxicology screens.	30, 90 and 365 days of ongoing treatment	Wilcoxon rank sum test; Chi-squared; Generalized estimating equations to adjust for covariates	Percent attaining 90 days consecutive abstinence in videoconference 49% vs in-person 37% (p = .31).	No differences were found between the telemedicine and in-person groups in substance use, time to 30 and 90 days abstinence, and 90 and 365 days treatment retention.

[a] Substance use and treatment attendance outcomes reported in (Tarp, Bojesen, et al., 2017) and satisfaction reported in (Tarp, Mejldal, & Nielsen, 2017).
[b] Refers to primary intervention type being studied. Several studies also included additional components that were available (see notes below).
[c] Participants in both arms could also receive nicotine patches.
[d] Participants in both arms were in an outpatient substance use disorder treatment program where medication treatment was also available.
[e] Participants in both groups also received in-person group psychotherapy.

was comparability of groups assessed? Assessment of bias was conducted by two coauthors (LL and DC) and differences in assessments were resolved through discussion with a third co-author (SM).

3. Results

3.1. Study characteristics

Among the studies included, all focused on adults with tobacco ($n = 3$), alcohol ($n = 5$) or opioid ($n = 5$) use disorders. The earliest year of publication among the studies was 2005. Studies were conducted in the United States ($n = 10$), Canada ($n = 2$), and Denmark ($n = 1$). The sample sizes of studies ranged from 18 (a single arm pilot) to 3733 (a retrospective comparison study). Sample sizes of the randomized trials ranged from 30 to 566. Mean ages of study participants ranged from 30.5 to 52. There was substantial variability in gender of participants with one study including only women and another only men. Nine studies reported race/ethnicity and participants of most of those studies were predominantly Caucasian. Several studies recruited from specific patient populations including rural (Carlson et al., 2012; Chang et al., 2018; Staton-Tindall, Havens, Webster, & Leukefeld, 2014; Weintraub et al., 2018; Zheng et al., 2017) and criminal justice involved (Staton-Tindall et al., 2014).

3.2. Intervention design

Studies varied widely in complexity and interventions included. Among the three studies focusing on nicotine use disorder, all encompassed psychoeducation and psychotherapy or counseling components. Kim and colleagues also provided transdermal nicotine patches to both study arms and Richter and colleagues also provided guidance to participants to help them select and obtain pharmacotherapy for nicotine cessation. Among the five studies focusing on risky alcohol use and alcohol use disorders, all provided psychotherapy but no studies included any forms of medication treatment. Among the five studies focusing on opioid use disorders, two focused on delivering psychotherapy to individuals who were receiving usual in-person treatment with methadone maintenance. The remaining three non-randomized studies examined use of videoconference-delivered medication treatment, primarily buprenorphine and methadone, delivered within an outpatient treatment setting. Treatment encompassed visits with a patient located at a rural clinic and a physician at a distant site and included other components such as urine toxicology screens.

The selected studies included both individual and group-based treatments. For studies that included a comparison group, the comparisons varied from in-person delivered treatment, phone-based treatment for two nicotine studies and one study comparing to usual care that did not include a major treatment component. Treatment intensity varied from two sessions over two months (Baca & Manuel, 2007) to ongoing treatment visits for interventions involving medication treatment for opioid use disorders.

3.3. Telemedicine components

Several studies focused on videoconference psychotherapy interventions delivered to participants' homes while other studies delivered treatment to patients located at distant clinics or other facilities away from their providers. None of the studies focusing on medication treatment delivered the interventions to participants' homes. Several studies included descriptions of telemedicine technology used (Carlson et al., 2012; Frueh, Henderson, & Myrick, 2005; Richter et al., 2015; Staton-Tindall et al., 2014; Tarp, Bojesen, et al., 2017) and a few studies described technical problems that may have affected participant recruitment or retention (King et al., 2009; King, Brooner, Peirce, Kolodner, & Kidorf, 2014; Tarp, Bojesen, et al., 2017).

3.4. Outcomes measured

Studies examined a number of outcomes, which are detailed in Table 1. Most studies reported outcomes related to substance use or abstinence through self-report and/or biological measures of substance use including urine toxicology analysis and salivary cotinine for nicotine studies. Several studies, including all studies delivering medication treatment for opioid use disorders, assessed retention in the treatment program. Many studies included measures of acceptability and feasibility including assessments of refusal, patient satisfaction with treatment, therapeutic alliance, and satisfaction with the technology. Frueh and colleagues also included qualitative interviews with participants to assess perceptions of treatment to guide future improvements (Frueh et al., 2005).

3.5. Effectiveness

Studies included in this review encompassed a wide range of telemedicine interventions to deliver treatment for SUDs and differed in the types of comparison groups used (Table 2). However, most studies focused on substance use and treatment retention or acceptability as outcomes. Notably, none of the included studies described a non-inferiority design that specifically assessed whether the intervention was not significantly worse than usual in-person delivered care.

3.5.1. Tobacco

Among studies examining interventions for nicotine use disorder, the videoconferencing interventions were not significantly better than the in-person (Carlson et al., 2012) or telephone conditions (Kim et al., 2016; Richter et al., 2015) in terms of abstinence rates. Studies generally found satisfaction was quite high with the videoconference interventions and participants would recommend the intervention to others. Some participants reported that the increased convenience was very important and that they would have had difficulty obtaining the interventions without telemedicine (Carlson et al., 2012).

3.5.2. Alcohol

Among studies examining alcohol use interventions, Tarp and colleagues found lower dropout in the telemedicine group, including a higher proportion of patients in the telemedicine group still in treatment at 6 months and 1 year (Tarp, Bojesen, et al., 2017) and De Leo and colleagues found a significant reduction in alcohol consumption from baseline to two month follow-up, though there was no comparison group (De Leo, Lamb, LaRowe, & Santa Ana, 2014). In contrast, in a study focusing on motivational enhancement therapy for individuals recruited from community supervision with criminal justice involvement, there was no significant difference in any alcohol use outcomes compared to usual treatment (Staton-Tindall et al., 2014).

3.5.3. Opioid

All studies examining videoconference-delivered medication treatment for opioid use disorders were non-randomized retrospective studies. Eibl and colleagues found the videoconference group were more likely retained in treatment at one year compared to those who received the majority of visits in-person. Zheng and colleagues found no significant difference in time to abstinence and 90 and 365-day retention comparing patients receiving medication treatment via videoconference to those receiving in-person care. Weintraub and colleagues found > 50% retention at 12 weeks (but no comparison group). Among two studies comparing videoconference-delivered psychotherapy to in-person psychotherapy for methadone patients, both found no difference in number of sessions attended and no differences in percent of drug positive urines during follow-up (King et al., 2014, 2009). King and colleagues also examined participant and therapist ratings of therapeutic alliance and found no difference in therapeutic alliance which were high throughout both conditions (King et al., 2014).

Table 3
Assessment of risk of bias for included studies.

Randomized controlled trials

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants & personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)
Baca & Manuel, 2007	?	?	+	?	?	?
Kim et al., 2016	−	−	+	−	−	−
King et al., 2009	−	?	+	?	?	?
King et al., 2014	?	?	+	?	−	?
Richter et al., 2015	−	−	+	−	−	−
Staton-Tindall et al., 2014	−	?	+	?	−	−
Tarp, Bojesen, et al., 2017	−	−	+	+	−	−

Non-randomized studies

	Was there a comparison?	How were the individuals/groups assigned?	Was the baseline and allocation to intervention prospective?	Was outcome assessment prospective?	Was hypothesis generation prospective?	Was comparability of groups assessed?
Carlson et al., 2012	Yes	Location of residence (i.e. urban or rural)	Yes	Yes	?	Yes
Chang et al., 2018, Weintraub et al., 2018	No	No assignment, data on first 177 patients who received treatment	N/A	N/A	N/A	N/A
De Leo et al., 2014	No	No assignment, data on 11 patients who completed treatment	N/A	N/A	N/A	N/A
Eibl et al., 2017	Yes	Retrospectively based on treatment received	No	No	Yes	Yes
Frueh et al., 2005	No	No assignment, non-randomized open pilot	N/A	Yes	N/A	N/A
Zheng et al., 2017	Yes	Retrospectively, based on treatment received	No	No	?	Yes

+ indicates high risk of bias, − indicates low risk of bias, ? indicates unclear risk of bias.

3.6. Risk of bias

We assessed studies for risk of bias using guidance from the Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green, 2011). Overall, assessment of risk of bias was limited by inadequate methodological details in many of the studies (see Table 3). For the RCTs, the most common source of risk of bias was lack of blinding of participants and personnel. In general, blinding of participants may not be possible for telemedicine treatment delivery trials. However, additional measures such as ensuring that study staff who are obtaining outcomes are blinded, are potentially possible and may be helpful to minimize risk of bias. In addition, there were areas where potential sources of risk was unclear due to lack of available information including blinding of outcome assessment and selective reporting (i.e. descriptions of all outcomes measured to minimize chance of only reporting significant results). Our assessment of risk of bias for the non-randomized studies was also challenged by limited information from published study methods. Overall, a major potential source of bias was lack of comparison groups, which was the case for three of the six non-randomized studies. In addition, other potential sources of potential bias included few studies describing hypotheses that were prospectively generated and limited comparisons of patient characteristics when there were comparison groups to assess for potential confounders.

4. Discussion

Individuals with SUDs experience one of largest gaps between treatment need and treatment utilization, with only a minority receiving treatment (Park-Lee et al., 2017). Challenges with treatment engagement and treatment access contribute to this gap. Telemedicine has been shown to be a promising approach to expanding reach and access to mental health and other chronic disease treatment. In this review, we systematically examined literature on interventions delivering SUD treatment via synchronous videoconference that assessed clinical impacts on substance use, treatment retention and acceptability and feasibility. We categorized interventions by substances that were targeted, including nicotine, alcohol and opioids. However, we did not find telemedicine interventions for other SUDs including cannabis and stimulant use disorders. Through this review, we find that telemedicine interventions delivering treatment for SUDs are promising, especially when treatments are less available otherwise, but data from studies to date are limited and additional studies are critically needed.

Several of the studies suggest that telemedicine could be associated with improved treatment retention when compared to participants having to travel for in-person treatment. A non-randomized comparison study of medication treatment for opioid use disorder (Eibl et al., 2017) found superior treatment retention and one small RCT of psychotherapy for alcohol use disorder found lower dropout for participants receiving telemedicine (Tarp, Bojesen, et al., 2017). Retention is particularly important for medication treatment for opioid use disorder, where patients, especially those in rural areas, often have to travel long distances for treatment that is ongoing and active receipt of medication treatment has been associated with improved mortality and other outcomes (Larochelle et al., 2018; Nielsen, Larance, & Lintzeris, 2017). In total, there were three studies, including two retrospective comparison studies and one single arm retrospective study suggesting telemedicine may be a promising approach for opioid use disorder medication treatment, but additional RCTs are needed to further examine this question (Chang et al., 2018; Eibl et al., 2017; Weintraub et al., 2018; Zheng et al., 2017).

In addition, studies suggested telemedicine interventions could be feasible and acceptable across a range of SUDs including nicotine, alcohol and opioids. Furthermore, many of the studies integrated telemedicine into real-world treatment programs and some integrated pragmatic design features. For example, the study by Tarp and colleagues randomized participants to either a usual care outpatient treatment program for alcohol use disorders or to the intervention condition, which allowed participants to elect individual therapy sessions to be delivered via videoconference. Although it may be difficult to generalize these findings, this approach suggests telemedicine could potentially be implemented in existing treatment programs and healthcare systems.

Many of the studies examined client satisfaction and found that overall satisfaction was quite high with telemedicine and was comparable to in-person treatment. However, several studies, including those that used web-based applications to participants at home, noted a number of technical challenges (Kim et al., 2016; King et al., 2014, 2009). King and colleagues noted that 26 participants in the telemedicine arm out of 85 participants randomized withdrew before receiving any treatment due to technical difficulties or losing interest (King et al., 2014). Telemedicine is expanding rapidly across healthcare (Nochomovitz & Sharma, 2018; Tuckson, Edmunds, & Hodgkins, 2017), and technological advances will likely lead to more reliable equipment and potentially greater sense of comfort from patients. Newer studies should continue to examine the impact of technological challenges, in particular with interventions delivered to participants' homes that rely on participants to setup equipment. In addition, future studies should also further examine clinician perceptions of satisfaction and usability, which may also be key to broader implementation.

We also noted several key limitations of the studies to date. Overall, it was challenging to reach clear conclusions about the effectiveness of telemedicine for SUDs. There were relatively few studies and most were designed as nonrandomized or small pilot studies. In total, there were 7 RCTs, including 3 RCTs with < 50 participants and there were no RCTs of interventions that examined telemedicine-delivered medication treatment; these were all conducted as non-randomized studies. The largest RCT by far was one study with a total of 566 participants that examined telemedicine delivery of counseling for tobacco use. In addition, there was a wide variety of comparison groups, from in-person delivered treatment to phone delivered treatment and usual care, which limits our ability to summarize across studies and make conclusions on effectiveness.

The comparison groups are key because they represent different questions that can be examined, but studies with different comparison groups answer different questions and would be challenging to combine. The relevance of these comparisons depends on the availability, cost and effectiveness of the comparison, which likely differs across SUDs and across locations. For interventions that can be effectively delivered by phone, comparing telemedicine versus phone is likely most relevant. Overall no study demonstrated that videoconferencing delivered counseling was better than phone delivered counseling for nicotine use disorder and costs were higher for telemedicine. However, for medication treatments, which often cannot be delivered by phone, and for other psychotherapy interventions, where there is less evidence supporting phone-based interventions, comparison to in-person treatment is most relevant. Studies are also further differentiated by either non-inferiority or superiority designs. Although many of the included studies found that participants in the telemedicine arms had comparable outcomes to those receiving in-person treatment, there were no studies specifically designed or powered to test the question of non-inferiority to standard in-person treatment. However, in locations and for treatments that are much less accessible, telemedicine interventions may be more effective than in-person treatment if measuring outcomes such as initiation and retention in treatment. Additional adequately powered studies are needed across these different comparisons that can help inform what settings and what SUD treatments can be delivered effectively via telemedicine.

Despite some of the current limitations of the studies, we conclude that especially when evidence-based treatments are not readily available, telemedicine-delivered treatments are a promising alternative. For specific treatment and substance use categories, particularly when treatment retention is the key outcome, it is also possible that

telemedicine could result in greater treatment retention due to increased accessibility for patients.

4.1. Future research

Given the limited literature identified in this review, it is particularly important to consider how to design future studies to address some of the potential sources of bias and limitations of studies to date.

First, additional RCTs should include rigorously designed studies with published protocols that prospectively define the question and primary outcomes of interest. Adequately powered RCTs comparing telemedicine to in-person are important, particularly with medication treatments, to inform effectiveness of telemedicine on outcomes including substance use and treatment retention.

Second, further studies are also needed to assess acceptability and engagement by patients and providers. Limited patient engagement in treatment has been a longstanding challenge for SUD treatment. It is possible some patients may be more interested in telemedicine treatment because of increased accessibility. In addition, providers have expressed concerns around trust and patient communication in non-SUD telehealth studies (Chakrabarti, 2015). Further studies to assess acceptability to providers, especially of interventions focused on buprenorphine treatment, a controlled medication where there may be provider concerns around medication diversion (Lin, Lofwall, Walsh, Gordon, & Knudsen, 2018), may also help with future adoption.

Third, further studies should explore telemedicine interventions to patients' homes and to compare telemedicine interventions to patients at home versus in clinics. Especially with the advent of new technologies that can detect substance use remotely (e.g. remote monitoring of alcohol use), the feasibility of some telemedicine SUD interventions to patients' homes have likely increased (Gordon et al., 2017). However, the effectiveness of medication treatment delivered via telemedicine to patients' homes is unclear and there may be additional barriers, including federal and state regulatory barriers that may affect the ability to prescribe a controlled medication like buprenorphine to patients at home (Center for Connected Health Policy, 2018). In addition to research, thoughtful changes to the current complex patchwork of telemedicine regulatory and reimbursement policies (Center for Connected Health Policy, 2018) may also be needed before there can be increased utilization of telemedicine models of SUD care.

Fourth, non-randomized studies that rigorously examine potential confounders that may affect group assignment, including further studies that examine real-world use of telemedicine for SUDs, would add substantially to the literature to date. As telemedicine becomes more available, it will be critical to identify which patient subgroups would benefit more from telemedicine and which patients may benefit more from in-person care. In addition, assessments of quality and outcomes of telemedicine treatment will also be key.

Finally, there is a large need for studies that consider the implementation context. For example, in the area of telepsychiatry, numerous models of telemedicine have been developed, including those that are integrated into primary care settings, emergency room and inpatient settings and models that consider different levels of illness and treatment complexity from one-time consultations to high-intensity care delivered by specialists (Hilty et al., 2018). In comparison, the literature on telemedicine interventions for SUDs is undeniably underdeveloped. For example, future studies using a pragmatic stepped-wedge design, which would allow all sites eventually to receive the intervention, could help assess if the availability of telemedicine delivered SUD treatment would result in more patients receiving treatment in real-world clinical settings.

In conclusion, the increase in overdose and other serious consequences for patients with SUDs and the near ubiquitous challenges with access to effective treatment underscores the pressing need to develop models that can increase treatment reach and access. Telemedicine treatment interventions are promising not only in terms of effectiveness, but are also likely quite feasible given the technology in place and the rapid growth in telemedicine across healthcare. However, additional studies are also critically needed, addressing the methodological limitations of studies to date, to lead to telemedicine interventions that will be effective and utilized by patients with SUDs.

Conflicts of interest

Dr. Lin served as a consultant to the California Health Benefits Review Program. All other authors have no conflicts of interest to disclose.

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Appendix A

I. Search terms
   a. Searches included at least one of the following terms:
      1. Telehealth*
      2. Telemedicine*
      3. Live video, video conferencing*
      4. (Asynchronous) store and forward*
      5. Remote (patient) monitoring (consultation)*
      6. Telepsychiatry
      7. Telepsychology
      8. Telemental health
   b. Searches also included any of the substance use categories below.
      1. Substance use disorders
      2. Substance abuse (treatment)
      3. (Drug) addiction
      4. Alcohol, alcoholism
      5. Tobacco
      6. Cannabis
      7. Marijuana
      8. Stimulant
      9. Hallucinogen
      10. Opioid
   c. Search footnotes
      1. * indicates truncation of word stem
      2. Parentheses indicate that a word is optional in a phrase. For example “(Drug) Addiction” would mean search for “Addiction” with or without “Drug.”
      3. Comma indicates “OR”. For example “Alcohol, Alcoholism” means search for “Alcohol” or “Alcoholism.”

II. Search of conference proceedings
   a. We searched abstracts from the following conferences related to substance use disorders, which had readily available abstracts online: College on Problems of Drug Dependence 2009–2018 (abstracts published in *Drug and Alcohol Dependence*), Research Society on Alcoholism 2009–2018 (abstracts published in

Alcoholism: *Clinical and Experimental Research*), and American Society of Addiction Medicine 2013–2018 (abstracts published in *Journal of Addiction Medicine*).

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